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REVISION OF SOME CHLAMYDOMONAS SPECIES

By

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Abstract

Six species and one variety of the genus Chlamydomonas are described. The identification of unnamed strain confirms the validity of previously described species and brings new details to the description in *Chlamydomonas leptos* Moewus; *C. peterfii* Gerloff and *C. subtilis* Pringsheim. Variability in the cell structure was observed in *C. acidophila* Negoro; *C. debaryana* Goroschankin var. *atactogama* (Korshikov) Gerloff and the cell-wall structure was also studied in *C. gelatinosa* Korshikov.

Introduction

Genus Chlamydomonas was described for the first time by Ehrenberg (1833) (Icona Prima). Synonyms referring to this genus are compiled by Pascher (1927). No doubt the generic name is valid, since 1833 more than 600 species of Chlamydomonas have been described by different taxonomists like Goroschankin (1891), Lagerheim (1892), Dill (1895), Chodat (1902), Wille (1902), Snow (1903), West (1904), Playfair (1918), Schiller (1926), Fritsch (1927), Skuja (1927), Skvortzow (1929), Pringsheim (1930), Conrad (1931), Moewus (1933), Czurda (1935), Korshikov (1938), Brabez (1941), Nygaard (1945), Lund (1947), Bourrelly (1950), Fott (1956), Ettl (1958), Huber-pestalozzi (1961).

In this work the observations are made on the basis of taxonomy and morphology with special consideration of the variability in the species respecting the vegetative habitat, reproduction and development of the cell. The details of the inner protoplast structure and life cycle are of paramount importance for species identification. The observation of cultures enables one to follow the variability of cell shape and of the inner structure during the development from the zoospore to the sporangium or zygote respectively. The cultures were cultivated in Bold's basal medium in solution and on solidified agar. The cultures examined originated from Culture Collection of algae at the Botany Department Caroline University of Prague, from the Culture Collection of algae at Botany School Cambridge and from the Culture Collection CSAV, Prague.

Variability and diversity in *Chlamydomonas* species

The comparison of an alga in nature with the same growing in an artificial culture show morphological variabilities and at the same time show the constancy of its major characteristics. The increasing numbers of species is due to the fact that one species has been described several times under different names.

Moewus (1933), Czurda (1935), Gerloff (1940), Lund (1947), Chapman (1962) are of the opinion that many of the characteristic features can be modified under cultural conditions. In nature majority of them seem to be the different phases of life cycle of one specie. The shape of the cell alters with the age. Young cells are relatively narrower than the old cells. However species lacking a papilla never produce one under any condition. Species possessing a papilla may loose it in certain conditions notably in relation to size and age and non-motile stages (e.g. as in *C. snowie* Printz). However the type of papilla is constant in any one species though it may vary in size and prominance even in young motile cells.

The number of contractile vacoules is always constant. The presence or absence of stigma is also constant but in some species its position may be variable e.g. *C. paludosa* (Skvortzow) Farooqui. The position of nucleus is not constant, it may shift from anterior to posterior part of the cell.

The chloroplast varies from basic shape, In young cells and in zoospores it is always lateral but when the cells become older the chloroplast divides into lobes which grow from the periphery towards the centre and look like stellate chloroplast e.g. *C. hydra* Ettl. The presence or absence of pyrenoid is constant. It's position varies according to the thickness of the chloroplast e.g. *C. hydra* Ettl. Therefore Fott (1967) stresses that material containing healthy and actively multiplying cells must be used for diagnosis because it shows limited variabilities.

Chlamydomonas acidophilla Negoro

Negoro 1944, Sci. Rpts. Tokyo Bunrika Daigaku, Sect., B, 6/101: 324-325, fig. 6 (diagnosis iconotype). Fott 1964, P. 116-117, fig. 3: Fott & Mc Carthy 1964, 11/1: 116-117, fig. 1.

Synonymum

Chlamydomonas applanata Pringsneim var. *acidophilla* Fott 1965, 28: 145-146, fig. 1-5; non *Chlamydomonas acidophilla* Nygaard, p. 43, fig. 29.

Original description

"Zellen eiformig, basal breit abgrundet und vorne verschmalert, fast, spitz. Membran deutlich, of tabstehend, vorne zu einer sehr kleinen Papille verdickt, mit zwei Geisseln, die fast zweimal so lang als die Zelle selbst. Chromatophor topfformig, gelblich grun. Pyrenoid seitlich, in halber Zellhohe bis basal gelagret. Stigma manchmal imm vorderen Dritte, aber nicht selten annahernd in halber Korperhohe gelegen, deutlich scheibehenformig. Kern zentral. Kontraktile Vakuolen vorne, zwei (?). Lange 6-9 u, Breit 4-6 µ "(Negoro, 6/101: 324-325).

Strain examined

Fott 1954/1, locality: Frantiskovy Lanzne.

Description (Plate I)

Cells ovoid, ellipsoidal-ovoid, basal end broadly rounded, apical end bluntly pointed. Cell-wall very thin. Papilla absent.

Chloroplast parietal. Pyrenoid big, spherical or ellipsoidal in the lateral thickning of chloroplast, it is sorrounded by a sheath of starch grains. Stigma narrow, ellipsoidal in the upper part of the chloroplast. Nucleus not visible. Contractile vacuoles 2, placed anterior.

Flagella 2, not very close to each other 1,1/2 to 2 times longer than the cell length.

Dimensions: Cells 8.5-10 um in length, 4.2-8 um in breadth.

Reproduction: Asexual reproduction occur by repeated transverse and longitudinal divisions of protoplasts into 2-4 daughter cells.

Occurrence

Chlamydomonas acidophilla Negoro was described for the first time in 1944 from Carter Lake and from the mud of Solfatora in Japan. Second time Fott (1946) recorded this species from bog near Frantiskovy Lazne, Bohemia. I have studied this material from the Culture Collection of Botany Department, Charles University, Prague. Locality: Frantiskovy Lazne, Bohemia.

Note

In 1964, Fott recognized that *C. applanata* var. *acidophilla* is identical with *C. acidophilla* Negoro and therefore, he invalidated *C. acidophilla* Nygaard. However, in order to keep the validity of Chlamydomonas species described by Nygaard he proposed a new name as *Chlamydomonas nygaardi* Fott.

Fott and McCarthy (1964) studied once again *Chlamydomonas acidophilla* Negoro from Frantiskovy Lazne and they concluded that the species is identical to that of Negoro's *C. acidophilla*.

Chlamydomonas acidophilla Negoro shows little variations in the shape of the cell and in the structure of the cell-wall. Vegetative cells are ellipsoidal-ovoid (Pl.I, Figs. 1, 2, 3) with broadly rounded basal ends. Zoospores are narrow (pl. 1, Fig. 6). Sometimes a little asymmetrical cells are also observed (Pl. 1, Figs. 3, 6). The cells are rounded in cross view (Pl. 1, Figs. 4, 5).

The cell wall is very thin, close to the chloroplast; in some cases it is a little remote at the apex, looking like small papilla. In few cases I observed the remote cell-wall at the posterior end only (Pl. 1 Figs. 7, 8) while in other cells the cell-wall is equidistantly remoted from the protoplast (Pl. 1, Fig. 9) Zoospores are narrow, more or less spindle shaped (Pl. 1, Fig. 6). Motile stages are observed even in two months old cultures. Palmella stages could never be seen.

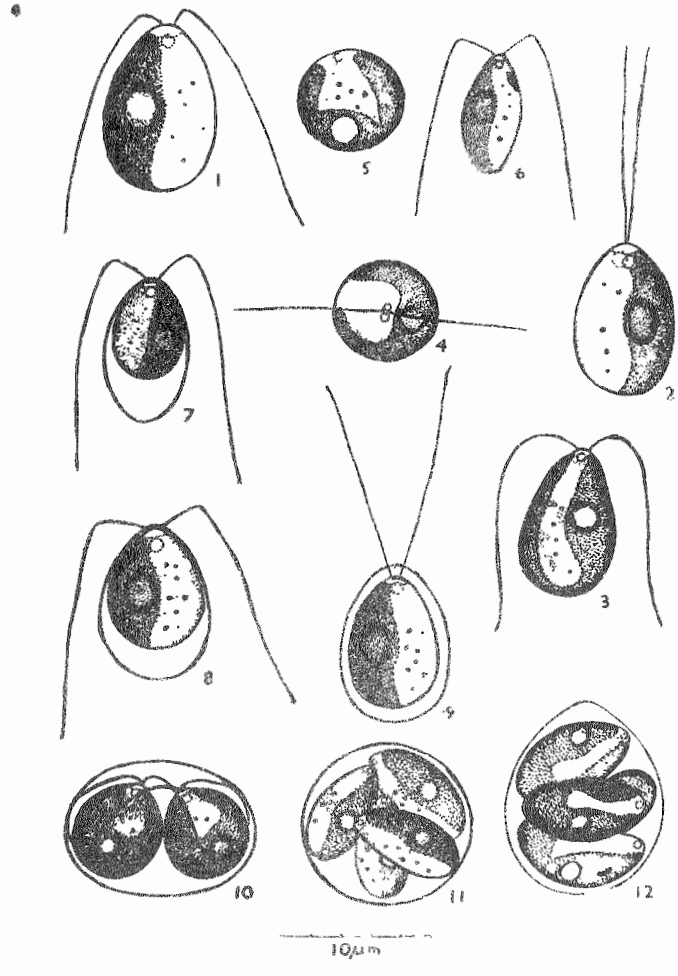

Plate 1

Chlamydomonas acidophilla Negoro- 1-3: typical vegetative cells; 4: top view of the motile cell; 5: a non-motile cell; 6: young vegetative cell; 7-8: cells with inflated cell-wall at the posterior end; 9: cells with equidistantly remoted cell-wall; 10: two daughter cells inside the mother cell-wall; 11-12: four daughter cells inside the mother cell-wall. (Drawn according to strain Pott 1954/1).

Chlamydomonas acidophilla Negoro is similar to *C. parietaria* Dill (in Huber-Pestalozzi 1961, p. 256-257, Fig. 294), differing in having papilla and smaller size of the

cell (16-18 × 9-11 um; to *C. parvula* Gerloff (1940, 93:380-384, Fig. 36), differing in the ellipsoidal shape of the cell and in the flagella as long as the body; to *C. teermulans* Rodhe and Skuje (in Huber-Pestalozzi 1961, p. 257, Fig. 295) differing in the dimensions of the cells (8-17 × 5-13 um); to *C. gracilis* Snow (1903, p. 374, Fig. 1) differing in the smaller dimensions (10.E5-13 × 6-55. Eum).

Chlamydomonas debaryana Goroshankin
var. *atactogama* (Korshikov) Gerloff

Gerloff 1940, Arch. Protistenk. 94: 455; Huber-Pestalozzi 1961, p. 187. fig.189.

Basionym :

Chlamydomona atactogama Korshikov in Pascher 1927, Susswasser-Flora 4: 230-231, fig. 178 (diagnosis, iconotype).

Original description

Zellen ellipsoidisch beidseits abgerundet. Membran zart, anliegend, vorne in eine fast halbkugelige Papille verdickt mit zwei annahrend korperlangen Geisseln. Chromatophor topfformig, Basalastuck ungemein verdickt, mit seiner geraden verderen Flache fast bis zur Mitte der Zelle reichend relative dunn, bis zur Creisselbasis gehend. Pyrenoid gross, kugelig, im Basalstucke. Stigma relative klein, aquatorial. Kern in der vorderen Halfte. Kontraktile Vakuolen zwei. Die erste Teilung beginnt der nach etwas schief und endet schliesslich quer. Es entatehen zwei order vier Tochterzellen. Gameten zu 2-16 gebildet, den vegetativen Tochterzellen vollig gleich, an Grosse ungemein wechselnd sowohl ausgesprochene Isogamie wie weitgehend Heterogamie vorkomen kann. Die Gameten sind behautet und stossen bei der Kopulation ihre Membranen auf einmal vollig ab. Zygozoospore langere Zeit beweglich. Reife zygote glatt. Zellen bis 14 u lang, 9 u breit. Zygoten 7-13 u imm Durchamesser. Russland: Charkow, (in Pascher 1927, 4:23 0-23 1).

Strain examined

Ettl 1958/1, locality not known.

Description (Plates: II & III).

Cells ellipsoidal, ovoid or ellipsoidal-ovoid, basal portion widely rounded, anterior portion slightly narrow. Cell-wall thin, distinct, close to the chloroplast. Papilla prominent, half rounded, wart-like at the anterior end of the cell.

Chloroplast deeply cup-shaped, comparatively thick in the basal region, thin at the side walls. Margin of the cup reach almost upto the base of the flagella, filling the cell cavity A big spherical or ellipsoidal pyrenoid lies in the basal thickening of the chloroplast. Pyrenoid is surrounded by a sheath of small starch grains. Stigma small, lying in anterior of the chloroplast Nucleus visible in the centre of the upper

half of the cell. 2 big contractile vacuoles placed anteriorly. Flagella 2, longer than the cell length.

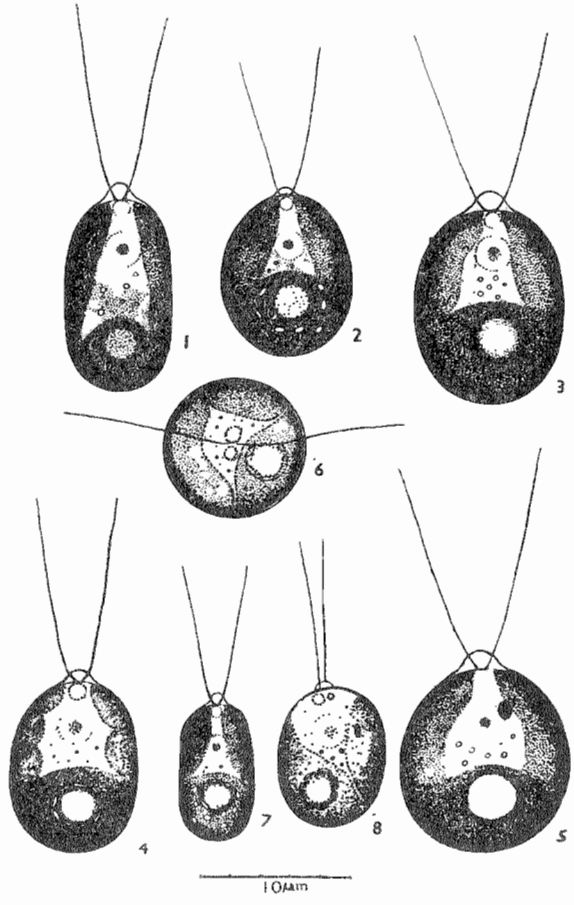

Plate II

Chlamydomonas debaryana Goroschaa ukin var. *arctogama* (Korshikov) Gerloff 1-3 typical vegetative cells; 4: an old vegetative cell having lobed chloroplast; 5: a vegetative cell with rounded shape; 6: top view of motile cell; 7: young vegetative cell in front view; 8: young vegetative cell at the side view. (Drawn according to strain Ettl 1958/1.)

Dimensions: Cells 10-14.5 um in length, 4.5-11.5 um in breadth.

Reproduction: Multiplication takes place as a result of successive division of chloroplast into 2,4 or rarely 8 individuals per cell. Gametes differ from the vegetative cells in having smaller dimensions and narrow size. They have papillae of smaller size as the vegetative cell and the flagella also emerge in the same manner, but fla-

gella are slightly longer than the body, having a small stigma and a pyrenoid. Sexual reproduction could not be seen.

Occurrence

Korshikov (1938) described *Chlamydomonas atactogama* from Kharkov (USSR). Second time it is described by Gerloff (1940), locality unknown. Holsinger (1935) recorded this species from the soil of a rice field in Ceylon. I have studied this material from the Culture Collection of Botany Department, Charles University, Prague. Strain Ettl 1958/1, locality unknown.

Note

My observations are in agreement with those of Korshikovs, on *Chlamydomonas atactogama* (in Pascher 1927) in the main morphological attributes, i.e. in the shape of the cell, shape of chloroplast, shape of papilla, position of stimga, contractile vacuoles and the nucleus. Dimensions of the cell are almost similar, only few of the cells that I observed are broader than in Korshikov's strain. As the major morphological characteristics agree, therefore I consider the strain Ettl 1958/1 as *Chlamydomonas debaryana* var. *atactogama* (Korshikov) Gerloff. It is kept in the Culture Collection of Botany Department, Charles University, Prague. under the designation *C. debaryana* Goroschankin.

I have not studied this species in nature, but the material exhibits slight differences in shape and size of cells while grown on different culture media. Cultures grown on Bold's sagar medium having more rounded cells than the cells of the cultures grown on solution medium. In agar medium the majority of the rounded cells have protruded cell wall at the posterior end of the cell (Pl. III, fig. 10). Very often some of the narrow cells have such protruded cell-wall (Pl. III, fig. 9).

Chalmydomonas debaryana var. *atactogama* is similar to *C. angulosa* Dill (in Huber-Pestalozzi, . 188, fig. 192) differing in square-shaped pyrenoid and dimensions of cells (20 × 12-15 um): To *C. subcylindracea* Korshikov (in Pascher 1927, 4: 232, fig. 197) differing in axial pyrenoid.

Chlamydomonas gelatinosa Korshikov

Korshikov in Pascher 1927, Susswasser-Flora 4: 210, fig. 154 (diagnosis, iconotype); Korshikov 1938, 4: 80, fig. 39.

Synonym

Sphaerellopsis gelatinosa (Korshikov) Gerloff 1940, 94: 485; Huber-Pestalozzi 1961, p. 455, fig. 627.

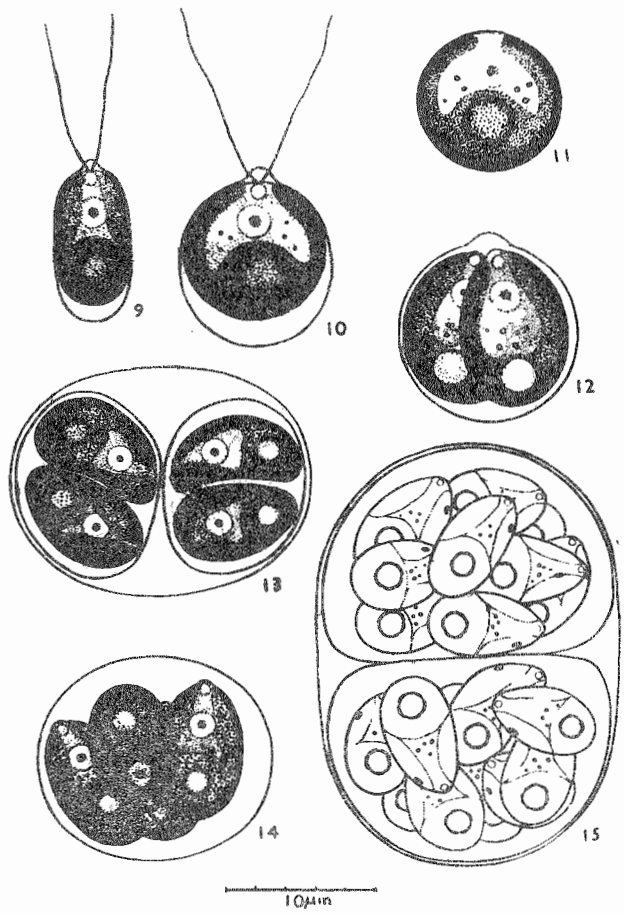

Plate III

Chlamydomonas debaryana Goroschankiniu var. *atactogama* (Korshikov) Gerlffi 9: young cell with inflated cell-wall at the posterior end; 10: a rounded cell with inflated cell-wall at the posterior end; 11: cross view of non-motile cell; 12: two daughter cells are enclosed inside the mother cell-wall; 13, 14: different arrangement of four daughter cells inside the mother cell-wall; 15: a plamelloid stage. (Drawn according to strain Etl 1958/1.)

Original description

"Zelle eiforming ellipsoidisch, basal breit abgerundet, nach vorne manchmal verschmalert, doch stumpf. Membran zart, oft vorre und basal vom Protoplasten abstehend, meist mit einer dicken Lage Schleim umgeben. Manchmal innerhalb der verschleimten erweiterten Membran, an der noch die Geisseln funktionieren, der Protoplast mit einer neuen Membran umgeben und mit neuen Geisslln versehen. Chromatophor sehr gross und topfformig, basal sehr stark verdickt: Wandstuck bis ganz

nach vorne reichend, manchmal nach vorne zu etwas verdickt. Pyrenoid in der baselen Verdickung. Stigma schmal eirund annahrerdin halber Zellhohe. Kern in der Zellmitte oder etwas nach vorne gelegen. Kontraktille Vacuolen vorn. Geisseln korperlang.

Zellen bis 20 u lang. Russland: Chrkow", (in Pascher 1927, 4: 210).

Strain examined

Fott, 1946/1, locality: a ditch in South Bohemia; Strain Baslerova/A15: locality thermal water in Piestany.

Description (Plates IV & V)

Cells ellipsoidal, ovoid or ellipsoidal-ovid, broadly rounded at the base, sometimes bluntly pointed at the apex. Cell-wall distinct, thick, gelatinised; in old cells very thick and stratified. Papilla absent.

Chloroplast cup-shaped with a basal thickening, covering the whole cavity of the cell. Pyrenoid big spherical, surrounded by a sheath of large starch grains; Pyrenoid lying in the basal thickening of the chloroplast. Stigma distinct, oval or ellipsoidal in the middle of the chloroplast. Nucleus visible at the anterior part of the cell. Contractile vacuoles 2, anterior.

Flagella 2, of equal length. 1½ times longer than the body. Dimensions: Cells 12-20 um in length, 8.5-18 um in breadth, with cell-wall 15-25 um in length, 10-20 in um breadth).

Reproduction: The protoplast divides asexually by successive divisions into 2-4 portions, which develop either into non-motile or flagellated daughter cells. The flagella of daughter cells can develop and move within the mother cell-wall, which becomes in this case aqueous and gelatinous. Sexual reproduction is not seen.

Occurrence

Korshikov described *Chlamydomonas gelatinosa* for the first time from Charkow, Russia. I have studied this species from the Culture Collection of Botany Department, Charles University, Prague: strain Fott 1946/1, locality: a ditch in South Bohemia; and from Culture Collection of CSAV, Prague, strain Baslerova A/15 locality: thermal water in Piestany.

Note

I have studied two strains of *Chlamydomonas gelationosa* Korshikov i.e. strain Fott 1946/1, and strain Baslerova/A15. Both the strains were identical in their morphology, but they differ in their physiology. Strain Fott 1946/1 grows in the temperature till 20°C and has shorter life, whereas strain Baslerova A/15 can grow upto 25°C and has longer life.

Chlamydomonas gelatinosa was described originally by Korshikov, later on Gerloff (1940) transferred this species into the genus *Spaerellopsis gelatinosa* (Korshikov) Gerl ff. But in my opinion the proper place for *Chlamydomonas gelatinosa* Korshikov is in the genus *Chlamydomonas*, as indicated by Korsikov.

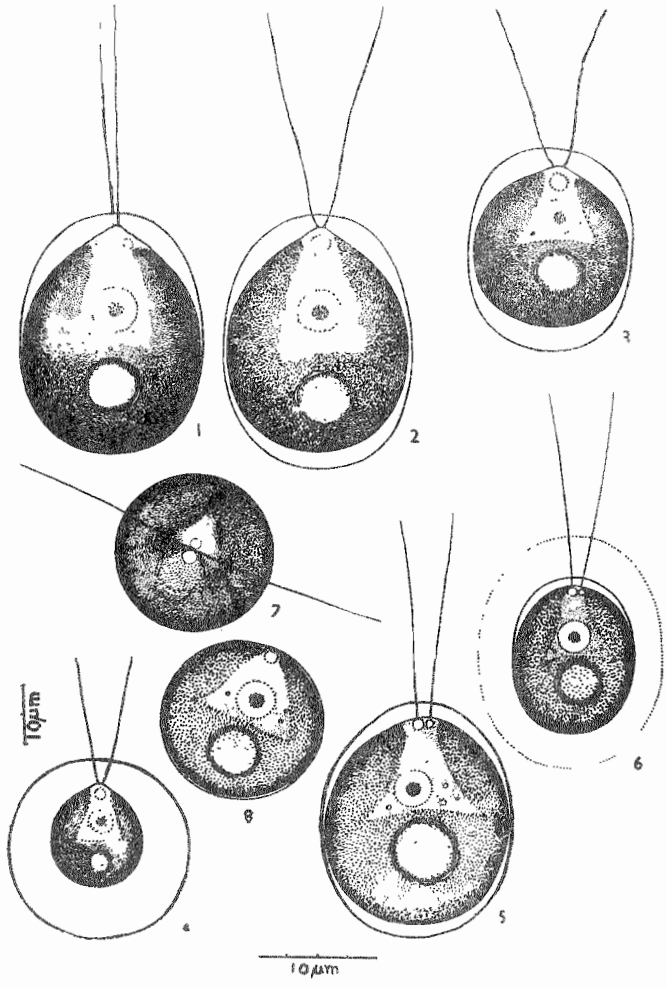

Plate IV

Chlamydomonas gelatonosa Korshiker-1: Vegetative cell in side view; 2, 3: two cells with inflated cell-wall at the anterior and posterior ends; 4: cells with equidistantly inflated cell-wall (measurements: 1um 2cms.); 5: vegetative cell in the side view with the inflated cell-wall, both at the anterior and posterior ends; 6: cells surrounded by mucilaginous cell-wall; 7: top view of motile cell. (Drawn according to strain Fott 1964/1.)

According to my own observations and those of Fott (personal communications) the species *Chlamydomonas gelatinosa* differs from the genus *Sphaerellopsis* in the following attributes:

In genus *Spbaerellopsil* the space between the cell-wall and the protoplast is filled with a thin mucilage or aqueous solution so that the shape of the protoplast is changeable. and it can exhibit various shapes; it may be stretched at both ends or bent

in a hook-like manner at the posterior end. The protoplast is broad at the middle: whereas in *C. gelatinosa* Korshikov the cell-wall in growing cells is a massive gelatinous substance, which keeps the protoplast always in a constant shape. The gelatinous cell-wall is sometimes strai fied ard many layered (Pl. V., fig. 9). In *C. gelatinosa*, as in the genus *Sphaerellopsis*, sometimes during the ontogeny of the cell the inner part of the cell-wall is filled up with aqueous solution ard enable the motility of the zoospores. This state however, is not constant.

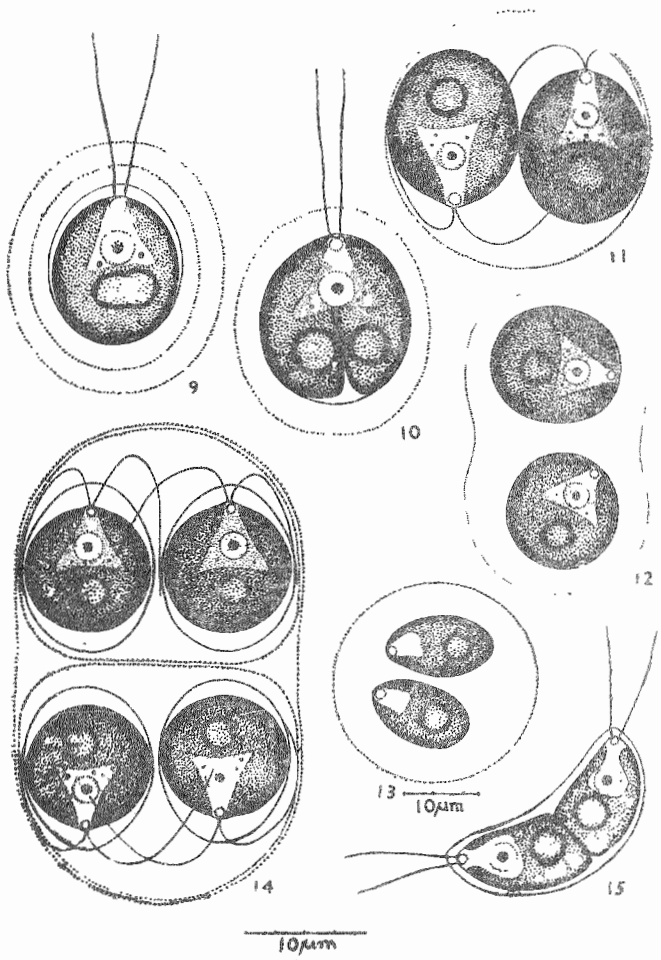

Plate V

Chlamydomonas gelatinosa Korshikov- 9: cells with dividing pyrenoid and surrounded by stratified mucilagenous cell-wall; 10: cell with dividing protoplast; 11: two motile daughter cells enclosed inside the mucilaginous cell-wall; 12, 13: different arrangement of non-motile cells inside mucilaginous cell-wall (fig. 13 drawn according to measurements: 1 um=2.5 cm.s); 14: four daughter cells with inflated cell-wall at both ends, embeded inside the mucilaginous cell-wall; 15: an anamolous stage. (Drawn according to strain Fott 1964/1).

The protoplast is ellipsoidal-ovoid, rarely ellipsoidal or rounded, sometimes bluntly pointed at the anterior end. But the cell-wall exhibits a vide range of variability. It is either close to the protoplast and relatively thick or away from the protoplast either at the anterior (Pl IV fig. 1) or posterior part of the cell (Pl. IV fig. 2, 3, 5), or equidistantly separate from the protopist (Pl. IV, fig. 4, 6). I consider this stage of cell development having equidistantly remote cell-wall layer from the form of the cell.

Chlamydomonas ampla Printz (in Pascher 1927, 4: 210-211, fig. 155) is a similar species in which the upper part of the protoplast is protruded in a short projection; the chloroplast is rather indistinct and the stigma is in the posterior part of the chloroplast. Even Pascher 1927, considers this specie is doubtful and incompletely described. Another similar species is *Chlamydomonas gloeosphaeram* Pascher and and Johoda 1928, 61: 254-255, fig. 9) differs in the rounded cell shape, elliptical which pyrenoid and streak-shaped stigma in the upper part of the cell.

Chlamydomonas leptos Meowus

Moewus 1931, Arch. Protistenk. 75: 288-289, fig. 6. (diagnosis, iconotypus); Huber-Pestalozzi 1961, p. 278, fig. 332.

Original descrption

"Zellen ellipsoidisch, vorn etwas zugespitzt. Membran derb, vorn Spitz auslaufend grossen, wandstandigen Scheiben. In halber Zellhohe liegt in einem mehr walzlichen Stuck ein kugeliges Pyrenoid. Ohne Augenfleck. Vorn zwei kontraktile vacuolen. Geisseln Kruperlang. Langsteilung. Lange der Zellen 11-14 μ. Breite 5-7 μ Aus einem Necklarteich; Rieselfelder Bielefeld ist im Prinzip topformig, ist aber einzelne wandstandige Scheiben zerfallen. Durch das Vorhandensein eines lateralen Pyrenoids in halber Zellhohe in einem starker entwickelten Chromatophorenteil muss die neue Art zur Untergattung Chlamydella gestellt warden" (Moewus 1931, 75: 288-289).

Strain examined

Komarek 1959/1, locality not known.

Description (Plate VI).

Cells ellipsoidal bluntly pointed at the apex and ovoid at the base. Cell-wall thin, close to the chloroplast, becomes a little inflated at the apex pretending a conical papilla. In the resting condition the cell surrounded by a thick mucilaginous layer.

Chloroplast cup-shaped, parietal, filling the cavity, leaving a small opening at the apex. In the mature vegetative cell the chloroplast divides into 3-7 irregular lobes by narrowslits. Pyrenoid spherical, lateral surrounded by sheath of starch grains, lying in the lateral thickening of chloroplast. Stigma absent. Nucleus distinct in the upper half of the cell. Contractile vacuoles placed anteriorly. May dark and light grains are scattered in the chloroplast.

Flagella 2, as long as body length, projecting from the top of the protoplast.

Dimensions: Cells 1 μm in length, 4.6-10 μm in breadth.

Reproduction: Vegetative reproduction takes place by the division of protoplast into 2, 4, 8 or rarely 16 daughter cells escape by rupture of mother cell-wall or they remain inside it and the mother cell-wall becomes mucilagenous. The division of the cell continues inside the mother cell-wall and as a result the mother cell-walls go on enlarging. Sexual reproduction not observed.

Occurrence

Moewus (1931) for the first time described *Chlamydomonas leptos* from Germany, Bielefeld, Riesefelder and from Nachlar pond. I recognized this species from the culture maintained in the Culture Collection of Botany Department, Charles University, Prague, strain Komark 1959/1, locality not known.

Note

The Komarek strain of *Chlamydomonas leptos* Moewus is very similar to Moewus's strain in most important morphological attributes, i.e. in the shape, flagella and contractile vacuoles. Measurement of the cells are almost the same, except that sometimes broader cells than the Moewus's strain are also observed. The species show little variability in the shape of the cell. Majority of the cells are ellipsoidal, but some times I observed more narrow cells at the anterior end (Pl VI fig. 5), bluntly pointed in a plasmatic protrusion (without Papilla), I often found cells more broad at the anterior side (Pl, VI Fig. 2).

The species was studied in culture only. Some differences in size are observed in the cells, growing in different culture media. Culture from agar medium had mostly ellipsoidal cells, often single cell enveloped by mucilagenous layer and without flagella. The mucilage became more clear when culture cells were stained with Indian ink. I observed sometimes 2 or more cells embedded in the stratified mucilagenous envelope (Pl. VI figs. 9,10). In the liquid medium culture there were mostly ellipsoidal cells, narrow at the anterior end (Pl. V fig. 5). Pyrenoid generally one in each cell, but two pyrenoids are also common, in which case one is bigger.

Chlamydomonas leptos Moewus resembles *C. botulus* Etl (1965, p. 376-377, fig. 71), differing in having Stigma and a little longer cells (12-18 × 5-10 μm).

Chlamydomonas peterfi Gerloff

Gerloff 1940, Arch. Protistenk. 94: 377-380, fig. 35; Huber-Pestalozzi 1961, p. 251, fig. 283; Peterfi 1966, Nova Hedwigia 10: 546-547.

Synonym

Chlamydomona pascheri Peterfi 1939, Bul. Grad. Bot. Muz. Bot. Univ..., Cluj 19: 87-104, fig. 1 (diagnosis, inconotype). Non *Chlamydomonas pascheri* Dangeard 1929, Le Botaniste 21: 296-299, pl. 23, fig. 1-12.

Original description

"Cellula ovoidea vel ellipsoidea, membrana distincta, tenui sine papilla antica, Hagella 2 cellulae aequilonga (10-13 μ), chloroplastus urneoformis, in parte latero-

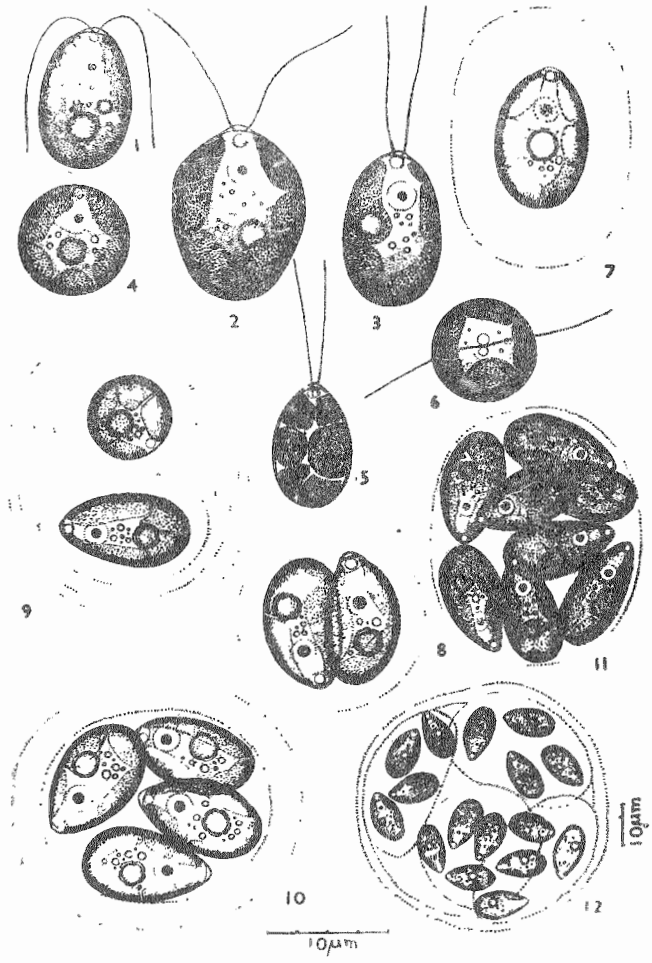

Plate VI

Chlamydomonas leptos Moewus — 1-3: typical vegetative cells; 4: non-motile cell in cross view; 5: surface view of the cell; 6: top view of the motile cell; 7: a non-motile cell surrounded by mucilaginous envelope; 8: two cells are enclosed inside the mucilaginous envelope; 9: two cells are enclosed by a stratified mucilagenous envelope; 10: four cells are enclosed inside a straitified mucilaginous envelope; 11: eight cells are enclosed inside a mucilaginous envelope; 12: a colony of cells, inside a big mucilaginous envelope showing palmelloid mood (drawn according to measurements 1 um - 4cms.)

posteriore pyrenoidem rotundum valde magnum (diam. 3, 3-4, 5 µ) portans Stigma ellipticeum in parte apicale dispositum. Nucleus in cellulae media parte situs. Vacuola contractilia bina. Long. cell. 10-13, 2 µ, lat. 5-8, 25 µ Formae per latitudinem dividuntur" (Peterfi 1939, 19: 4-5).

Strasin examined

Holubcova 1959/3. locality: Pancava, mountains Krkonose, North Bohemia.

Description (Plate VII)

Cells ellipsoidal, ovoid or ellipsoidal-ovoid, broadly rounded at the base, less rounded at the anterior end. Cell-wall thin, very close to the chloroplast. Cells without papilla.

Chloroplast cup-shaped, having irregular inner borders. It reaches till the base of the flagella filling the cell cavity, leaving a little hyaline portion free at the apex. Pyrenoid big, spherical, lies laterally in the chloroplast thickening; sometimes shifting towards the base of the cell (pretending a basal pyrenoid). Stigma small, ellipsoidal or oval, in the anterior part of the chloroplast. Nucleus distinct in the upper part of the cell, or in the middle of the cell. Contractile vacuoles 2, lying anteriorly in the hyaline portion of the protoplast.

Flagella 2 of equal length, little longer than the body length emerging close to each other.

Dimensions: Cells 10-13 μm in length, 7-10 μm in breadth.

Reproduction: Cells asexually divided by successive transverse divisions of protoplast into 2-4 or rarely 8 daughter cells. Gametes differ from the vegetative cells being smaller in size. Sexual reproduction is not seen.

Occurrence

Peterfi (1939) described *Chlamydomonas peterfii Pascheri* for the first time from Stana divala, Rumania. Second time it was reported by Gerloff (1940) from a Slime mold pond in Germany (Westrpignitz). Peterfi & Peterfi (1966) described this species again from Salica, Rumania. It was found abundantly in "Taul cu rogos" ard "Taul cu mestecni". I studied this species from the Culture Collection of Botany Department, Charles University, Prague, strain Holubcova 1959/3. locality Panchava, mountain Krkonosa, North Bohemia.

Note

Dangeard (1929) was the first who used the name *Chlamydomonas pascheri* Dangeard. Later on Peterfi (1939) described some other Chlamydomonas species under the same name *Chlamydomonas pascheri* peterfi. Gerloff (1940), studied both *C. pascheri* Dangeard and *C. pascheri* Peterfi, and as a result of his conclusion he left *C. pascheri* Dangeard at its previous position and renamed *C. pascheri* Peterfi as *Chlamydomonas peterfi* Gerloff.

According to my own observaions of *C. peterfii* Gerloff, cells are mostly ellipsoidal, sometimes ovoid or rounded at both ends (pl. VII, fig. 3). Cell wall thin, but sometimes it is remote at the posterior end in the old cells. In the young cells the chloroplast is lateral, (pl. VII, fig. 2) whereas, in the old cells it is divided into 3-5 lobes (pl. VII, fig. 4), splitted by narrow incisions. Position of pyrenoids is variable. Generally it is lateral in the middle of the chloroplast thickening; sometimes it is at the lower half of the cell (pl. VII, fig. 6).

Gerloff (1940), described *Chlamydomonas peterfii* Gerloff very similar to *C. media* Klebs var. *minor* Pascher (Pascher, 1927, 4: 263-25, fig. 221), differing in having papilla, and bigger dimensions (18-20 X 11-13 μm).

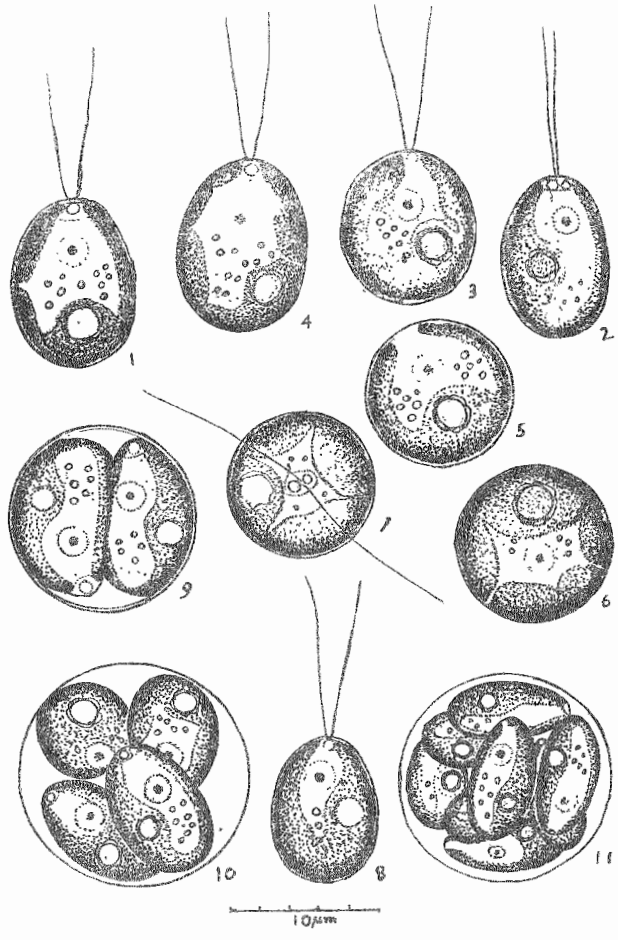

Plate VII

Chlamydomonas peterfii Gerloff - 1: vegetative cell in front view; 2: vegetative cell in the side view; 3, 4: two cells showing different positions of pyrenoids; 5, 6: two non-motile cells in the cross view; 7: top view of motile cell, 8: young vegetative cell; 9: two daughter cells inside the mother cell-wall; 10: four daughter cells inside mother cell-wall; 11: eight cells inside mother cell wall (Drawn according to strain Holubcoza 1959/8).

Chlamydomonas subtilis Pringsheim

Pringsheim 1930, Arch. Protistenk. 69: 100, fig. 21-22. (diagnosis, iconotypes); Huber-Pestalozzi 1961, p. 295-296, fig. 349.

Original description

"Zellen elliptisch bis kuglig. Keine Papille, zart Membran, die sich bei Teilung gallertartig verdickt. Geisseln 2 mal korperlang. Chromoatophor seitenstandig,

Vorder ard Hinterrende freilassend, ebenso etwa 1/4 der Zelle in der Langsrichtung.. Langsrander gellapt. Ein Pyrenoid in halber Zellhohe. Kern in der hinteren, Stigma in der vordederen Zellhafte. 2 pulsierende Vakuolen vorn. Auf sehr derbe, dunkelgrune, grosse Kolonien. in flussigem Erddekot nur kurz beweglich 1-2 Wochen. Grosse 7-10:6-10 μ. Aus Wasserpflenzebhassin im botan. Garten in Prag neben Volvox globator. Durch gellappten Chromatophor urd Grusse deutlich gekennzeichnet". (Pringsheim 1930, 69:100).

Strain examined

Felfoldy 1959/1, locality: Lake Balaton. Hungary.

Description (Pl. VIII).

Cells ellipsoidal, ovoid, rounded at the base, bluntly pointed at the apex, without papilla. Cell wall thin, slightly inflated at the apex.

Chloroplast lateral. In old vegetative cells it looks like to be divided into irregular lobes; but in the gametes it is not divided. Pyrenoid oval or ellipsoidal embedded in the lateral thickening, lying in the middle of the cell in chloroplast. Nucleus lies either in the posterior portion or in the middle of the cell. Stigma in the upper half of the chloroplast. Contractile vacuoles 2 placed anteriorly.

Flagella 2, either of the same length of the cell or 1½ times longer than the body.

Dimensions: Cells 7-12 μm in length, 4-9 μm in breadth.

Reproduction: Asexual reproduction occurs when the cell becomes non-motile and divides to form 2-4 rarely 8 daughter cells. Zoospores having flagella slightly longer than the body, with a distinct linear stigma and a pyrenoid.

Occurrence

Pringsheim (1930) described this species for the first time from Prague, Bohemia, in the Botanical Garden in a basin with flowering plants. Since that time no further observations were made. I have studied this species from the Culture Collection of Botany Department, Charles University, Prague, Strain Felfoldy 1957/1, isolated from the lake Balaton in Hungary.

Note

My observations are in accordance with that of Pringsheim's in the main morphological characteristics,i.e. in the shape of the cell and of the chloroplast, position of stigma, position of contractile vacuoles and the nucleus. The measurement of the cells are almost the same. However, I observed few cells narrower and longer than the Pringsheim's strain. The flagella in my material are shorter than the flagella in Pringsheim's drawings. In Pringsheim's species flagella are two times longer than the body length. while my specimens have flagella 1½ times longer than the body length. In my opinion these differences are not very important, as the major characteristics agree; because of it, I consider that Strain Felfoldy 1957/1 to be the

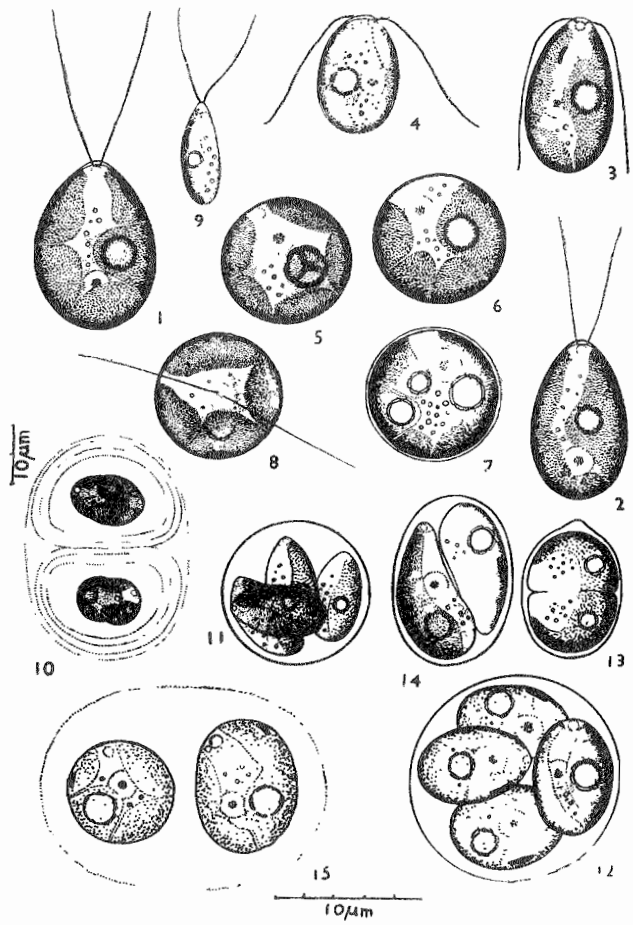

Plate VIII

Chlamydomonas subtilis Pringsheim—1-2: typical vegetative cells having nucleus at the posterior end of the cell; 3, 4: vegetative cell having nucleus at the middle of the cell; 5: non-motile cell; 6. non-motile cell in the cross view; 7: a non-motile cell with three pyrenoids; 8: top view of motile cell; 9: young vegetative cell; 10: four cells are embedded inside the stratified mucilage cell-wall (measurements according to 1 um = 2cms); 11, 12: four daughter cells are enclosed inside the mother cell-wall, showing different arrangements; 13: division of protoplast; 14: formation of daughter cells; 15: two cells are embedded inside the mucilagenous envelope. (Drawn according to strain Felfoldy 1957/1.)

same as *Chlamydomonas subtilis* Pringsheim which was kept in the Culture Collection of Botany Department, Charles University, Prague, as an unidentified Chlamydomonas sp.

Chlamydomonas subtilis Pringsheim shows little variability in the cell shape. In Pringsheim's description either ellipsoidal or rounded cells are pictured. I often observed ovoid or ellipsoidal-ovid cells (pl. VIII, fig. 1) Ellipsoidal cells are more frequent. Sometimes I found cells with the anterior end bluntly pointed in a low conical plasmatic protrusion (without papilla) (pl. VII , fig. 9).

There are also minor size differences in the cells cultivated on different culture media. I have not studied the material from the nature. The culture cultivated on agar medium having more rounded cells than the culture cultivated on solution medium. The cells from the agar medium are mostly non-motile, but a small stigma is visible, whereas cells from the solution medium are mostly motile and have comparatively bigger stigma.

Chlamydomonas subtilis shows a considerable variability in the position of nucleus. In majority of the cells the nucleus is situated in the anterior half of the cell, while in others, the position is either in the middle (pl. VIII, fig. 3, 4), or at the posterior end of the cell (pl. VIII, fig. 1, 2). Pyrenoid mostly one in a cell, but sometimes two or three pyrenoids are observed, in this case, one is bigger than the others. Shape of pyrenoid mostly globular, surrounded by a sheath of starch grains.

Pringsheim described some other species namely *Chlamydomonas oblonga* Pringsheim (1930, 69:97, fig. 6-11-); *C. minuta* Pringsheim (1930, 69: 98, fig. 12-13) *C. inflaxa* Pringsheim (1930, 69: 99, fig. 16-17); *C. oviformis* Pringsheim (1930, 69: 99, fig. 18-20). These species are morphologically so similar that it is not possible to differentiate one from the other. The similarities of all these species are seen from the drawings which represent the shape and size of the cells given by the Pringsheim (see original description). It is possible that the strains isolated belong to different taxa, but until substantiated by new diacritical characteristics, we have to retain them as doubtful and insufficiently described species.

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